

Examining the Mechanistic Diversity of M(II)-2OG Enzymes: The Role of Intrinsic Electric Fields

Wyatt Gibbs, Elvira Sayfutyarova

Department of Chemistry, The Pennsylvania State University, University Park, PA, 16802, United States

Elucidating the structure-function relationships in enzyme active sites has been of interest in bioinorganic chemistry as the transition metal complexes within these active sites facilitate a wide array of biochemical reactions. The intrinsic protein environment plays a large role in defining these structure-function relationships. Intrinsic electric fields (IEFs) derived from the protein environment have been shown to be key players for tuning catalytic function of an enzyme. By examining approximately 250 Fe(II)/Mn(II)-2-oxoglutarate (2OG) containing oxygenases, we calculated IEFs and observed trends differentiating catalytic function, supporting the pivotal role IEFs play in modulating enzyme activity. A special case of these enzymes, ethylene forming enzyme (EFE), shows an atypical mechanistic behavior compared to other members of the 2OG family. To further explore this, we examined geometric distortion trends in Fe(II)-2OG model complexes perturbed by applied electric fields. We find that IEFs contribute to changes in the geometry of the model complexes which may be conducive to future steps in the enzymatic process. These findings suggest functional dependence of IEFs on these enzymes as they may not only impact the reactivity but also influence the selectivity of competing pathways.